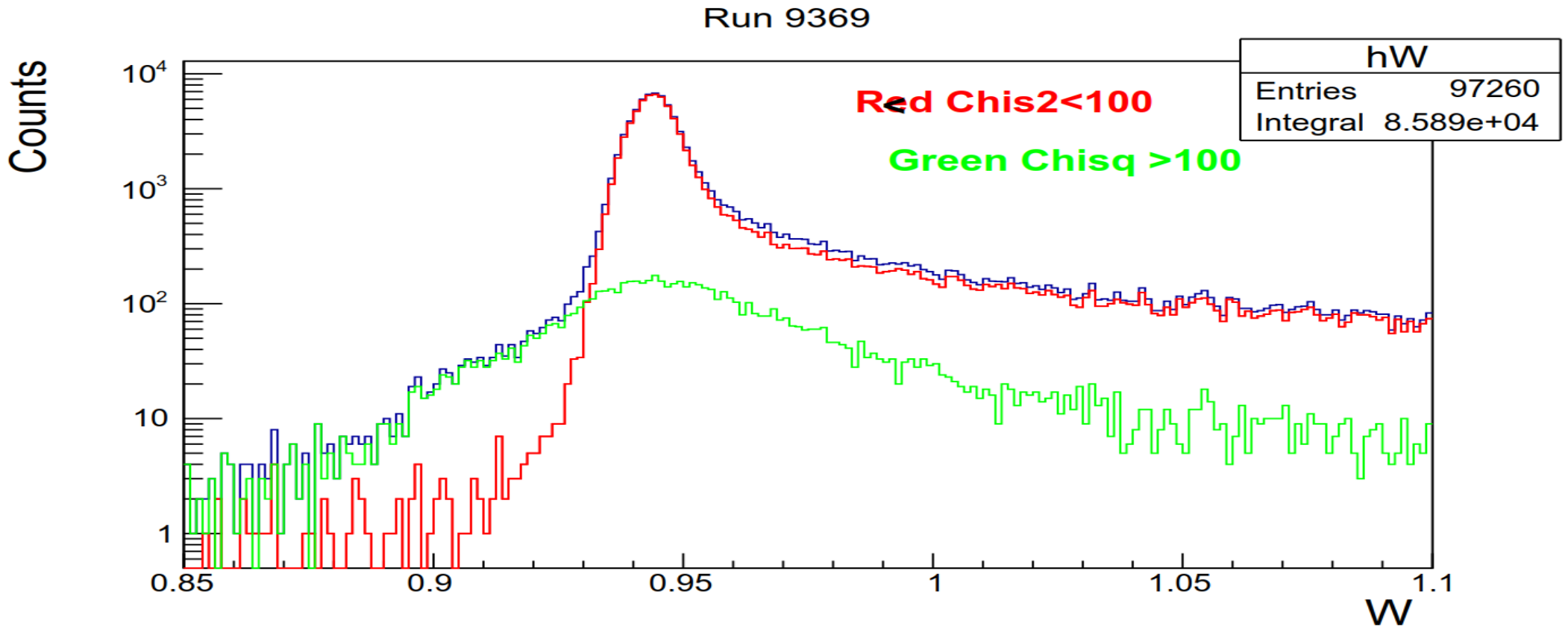
HCANA DC Update July 2021

Problem with golden tracks with Chisq > 100

- VCS data showed problem with excess events in MM2 below π^0 peak.
- Elastic data sees same problem with events at W < .92
- Resolution in W much worse for chisq> 100 events.
- In each arm chisq>100 is about 10% of the golden tracks.
  - ➢ 20% loss of events if chisq>100 event are cut.



Change HCANA to select DC hits in after Starttime correction

- Changed THcDriftChamberPlane::ProcessHits
  - Keep the initial filtering of DC hits using cut on the DC reference time subtracted time
  - p(h)dc_tdc_min_win and p(h)dc_tdc_max_win are array for each DC plane and units of channels.
  - Change to fills structure fFirstPassHits instead of fHits. fHits is used for clustering and tracking.
- Changed THcDriftChamberPlane::SubtractStartTime
  - fFirstPassHits are filtered
  - New time cut parameters : p(h)min_drifttime and p(h)max_drifttime in units of ns
  - If the Starttime subtracted DC time is within the new time cuts then fill fHits
  - p(h)min_drifttime and p(h)max_drifttime are one set of parameters for all planes and in units of ns.
  - Default values p(h)min_drifttime = -50 and p(h)max_drifttime =200 if not set as parameters.

- Main Goal:
  - Reduce the number of junk DC hits
    - Main cause for no tracks is too many hits in a chamber.
  - Maybe junk hits causing worse chisq

Created THcDC::NewLinkStubs

- Parameter flag p(h)UseNewLinkStubs=1 to use NewLinkStubs. By default UseNewLinkStubs=0
- Found the old LinkStubs method confusing to follow.
- NewLinkStubs is simple
  - No limit on number of spacepoints
  - Single limit on number of tracks MAXTRACK = 100 that is hard coded. (This could be a parameter)
  - Loops through spacepoints in Ch1
    - For each Ch1 spacepoint loops through Ch2 spacepoints
    - If stubs in Ch1 and Ch2 pass the xt_track_criterion, yt_track_criterion and xpt_track_criterion then a track is formed.
  - If after the above loops, no track is found, then makes tracks from all combinations of Ch1 and Ch2 spacepoints.
    - Allows one to put a loose cut values for xt_track_criterion, yt_track_criterion and xpt_track_criterion

- Main goals
  - Make code simpler to follow
  - Reduce the number of possible tracks with stub matching criterion,
    - ➢ But not reduce number of golden tracks

THcDriftChamber::NewFindSpacePoints

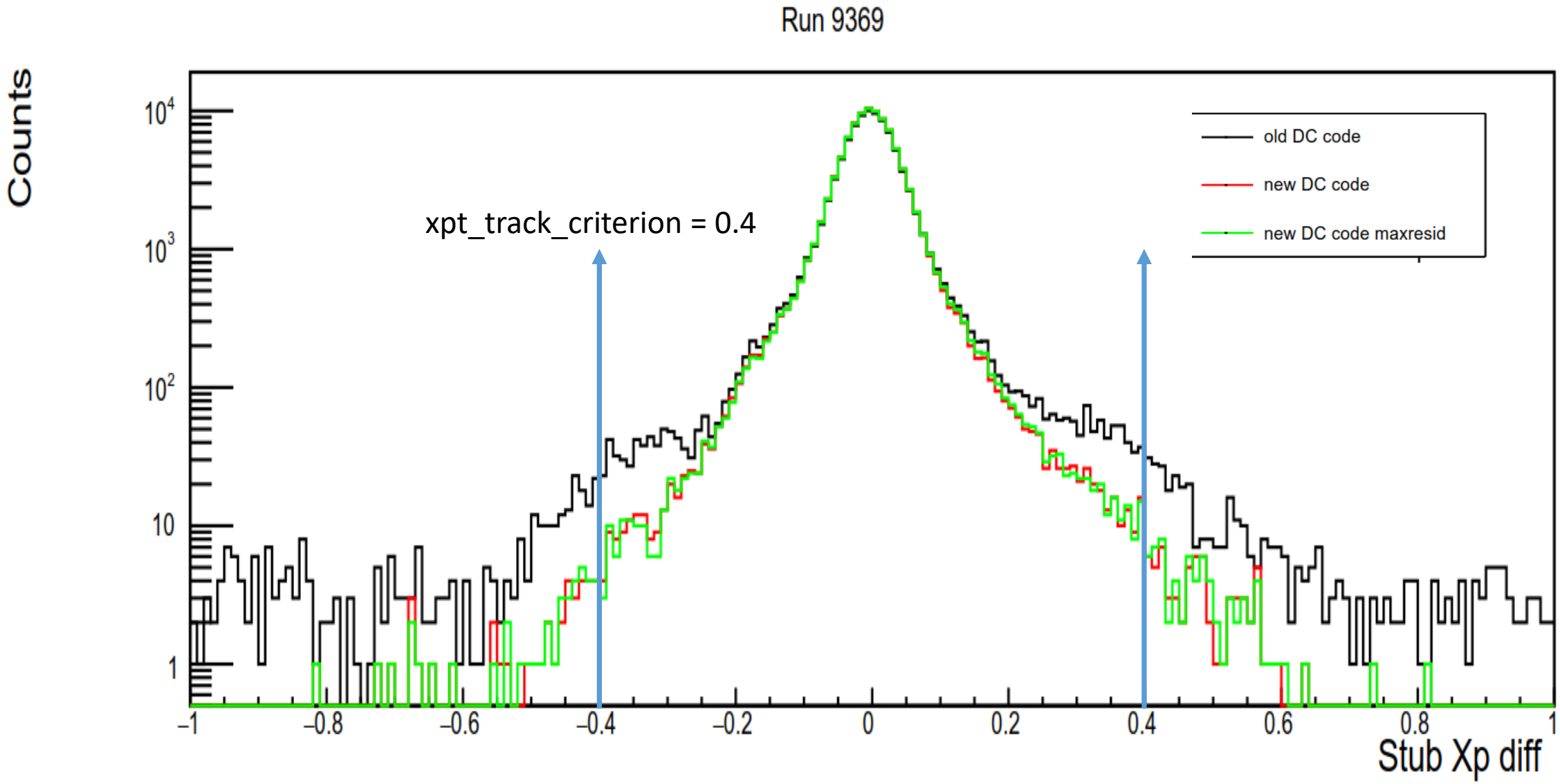
- Parameter flag p(h)UseFindSpacePoints=1 to use NewFindSpacePoints. By default NewFindSpacePoints=0
- Main philosophy
  - Since SHMS/HMS DC chambers similar layout, then clustering algorithm can be simpler.
  - Take advantage that the wires are staggered by 0.5cm in like planes.
  - Make clusters of hits in each UU', XX' and VV' plane pairs instead of pairs of unlike planes.
    - Two hit LL' cluster if the hits in each plane are within 0.6cm of each other
    - One hit in LL' cluster if no hit in in other plane within +/- 0.6cm
    - Hit can be in two LL' cluster if hits in other plane within -0.6cm and another at +0.6cm
  - Make clusters of UX and VX planes
    - Combine all combinations UU' and XX' into UX clusters.
    - Combine all combinations VV' and XX' into VX clusters.
    - Have X and Y position info in the UX and VX clusters.
  - Make spacepoints when meeting the criteria
    - UX and VX cluster having matching XX' hits
    - The dist2 = $(UX\_ypos - VX\_ypos)^2 + (UX\_xpos - VX\_xpos)^2 <$ SpacePointCriterion (use 0.5cm)

- New class THcDCPlaneCluster which store the hit info for the cluster

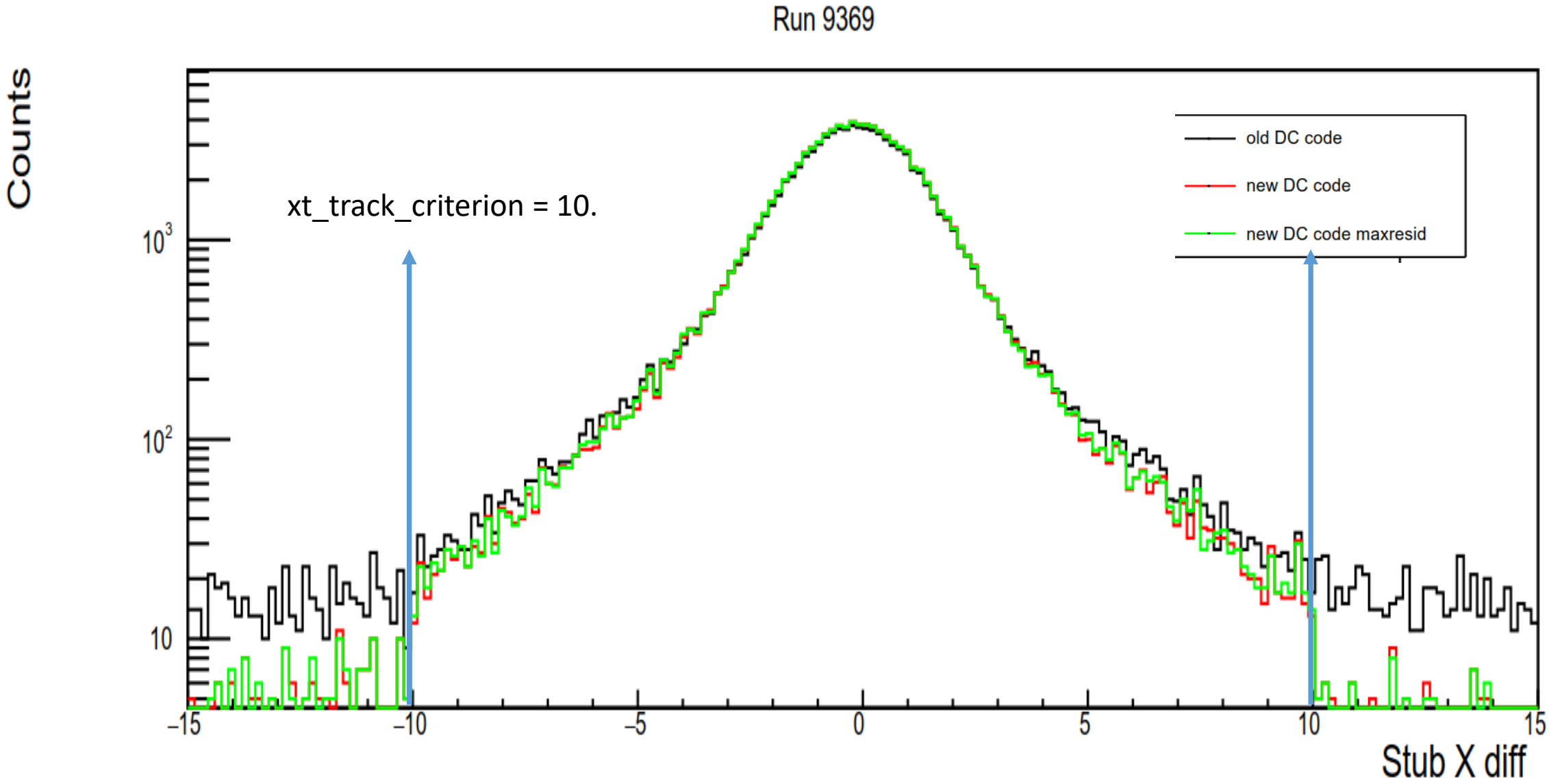
Modify THcDC::TrackFit to eliminate hit with largest residual

- Add parameter p(h)TrackLargeResidCut which is by default = -1 (not used).
  - p(h)TrackLargeResidCut is units of cm
- Modify TrackFit
  - Determined the hit with the largest residual, RL.
  - If p(h)TrackLargeResidCut == -1, then do not remove any hit.
  - If abs(RL) > p(h)TrackLargeResidCut , then remove hit from track and redo the fit.
  - Can only eliminate one hit from track.

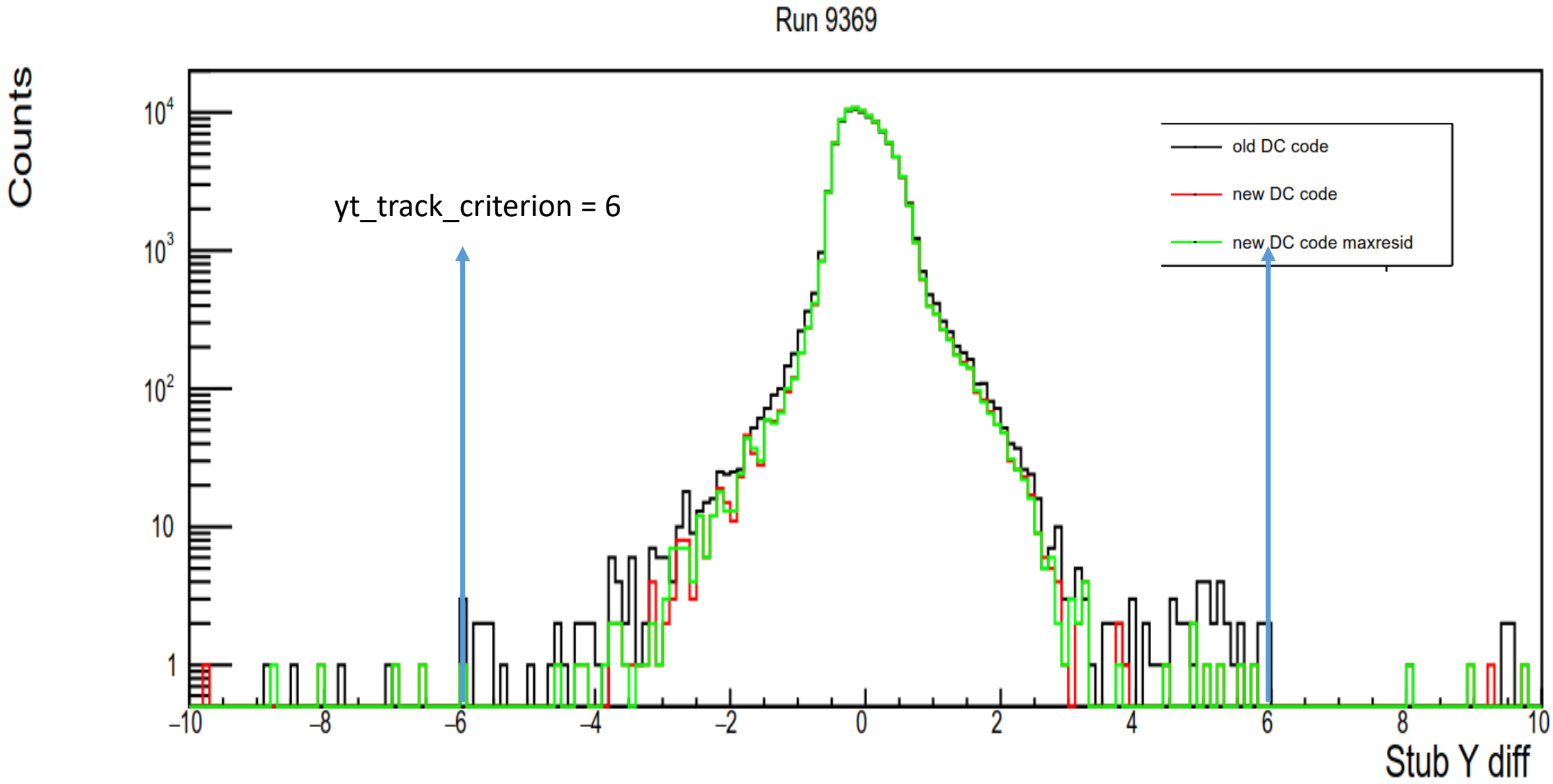
SHMS Xp Stubs Difference of golden track



SHMS X Stubs Difference of golden track

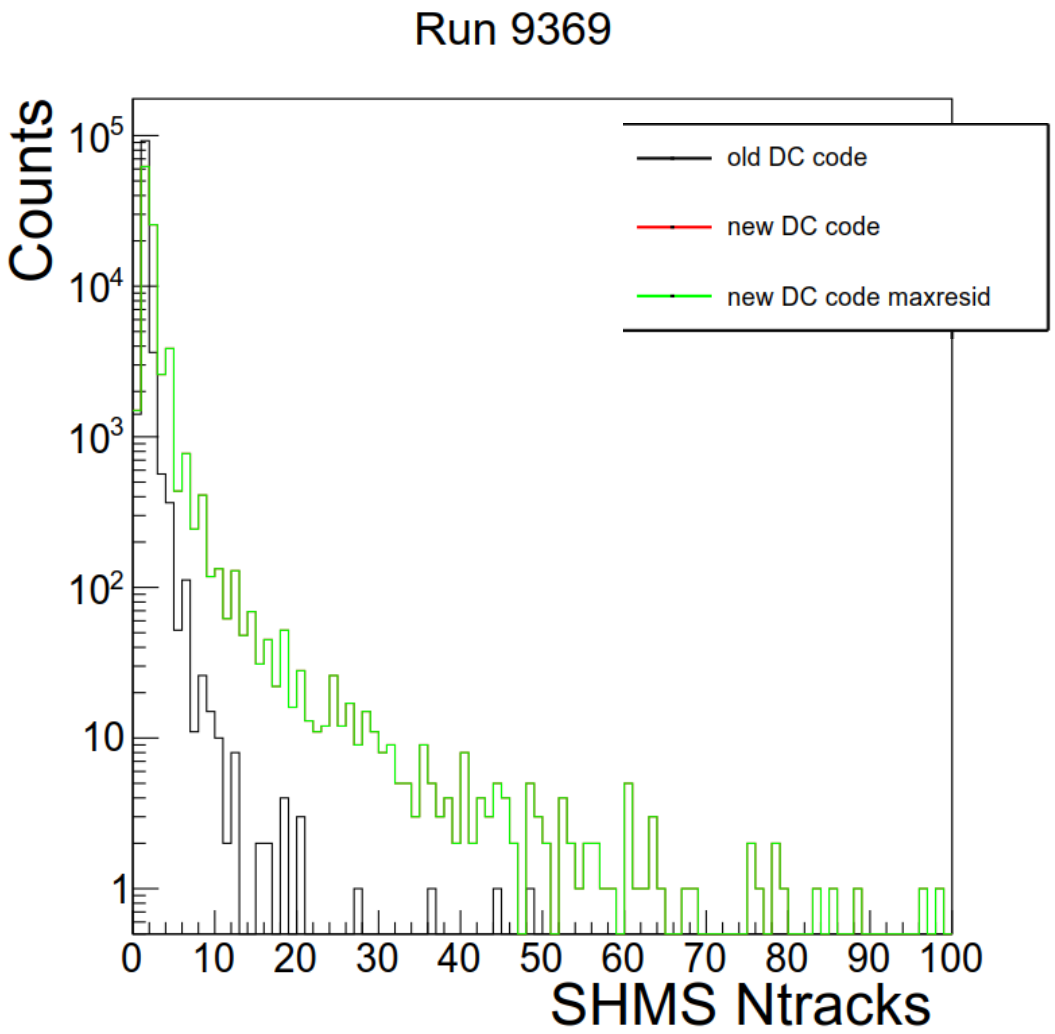


SHMS Y Stubs difference of golden track

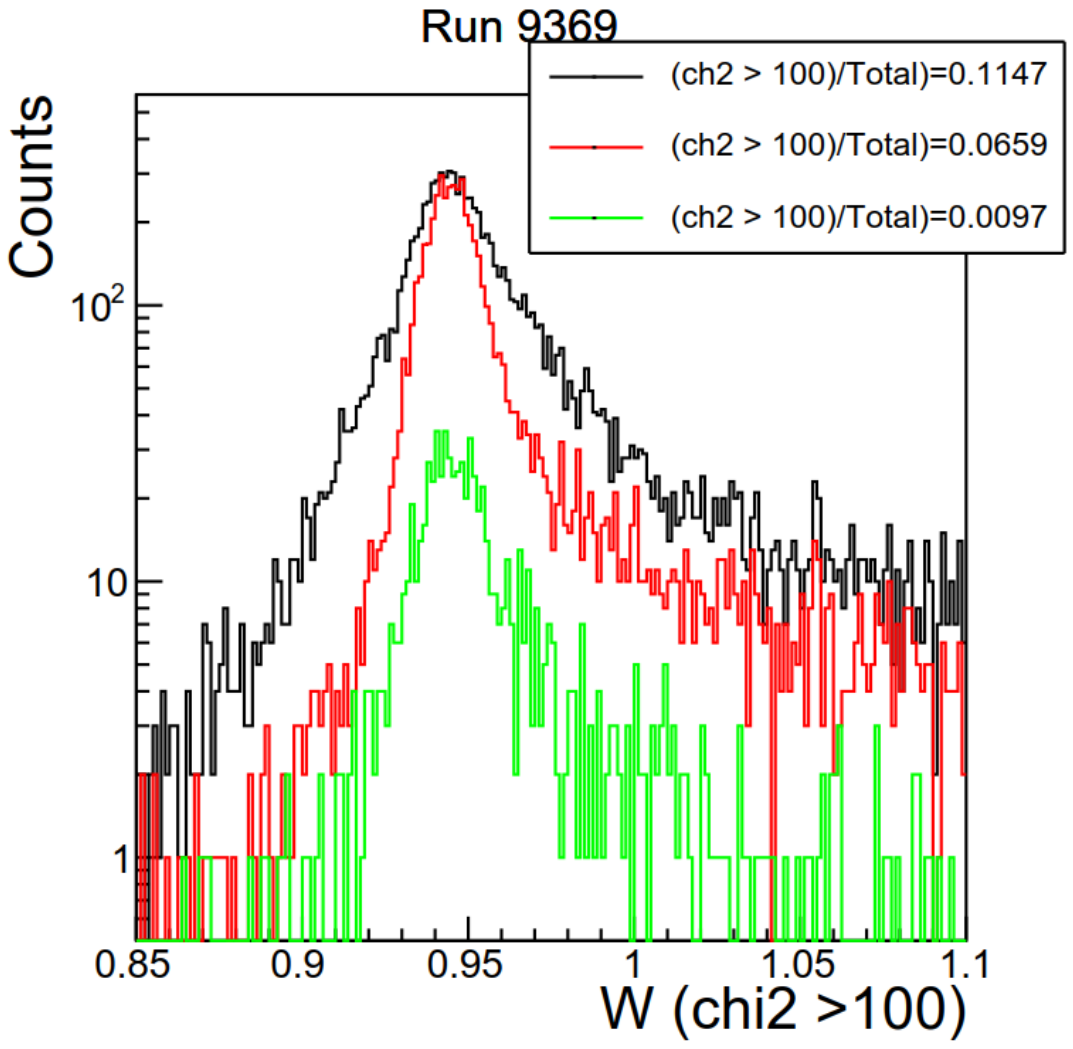


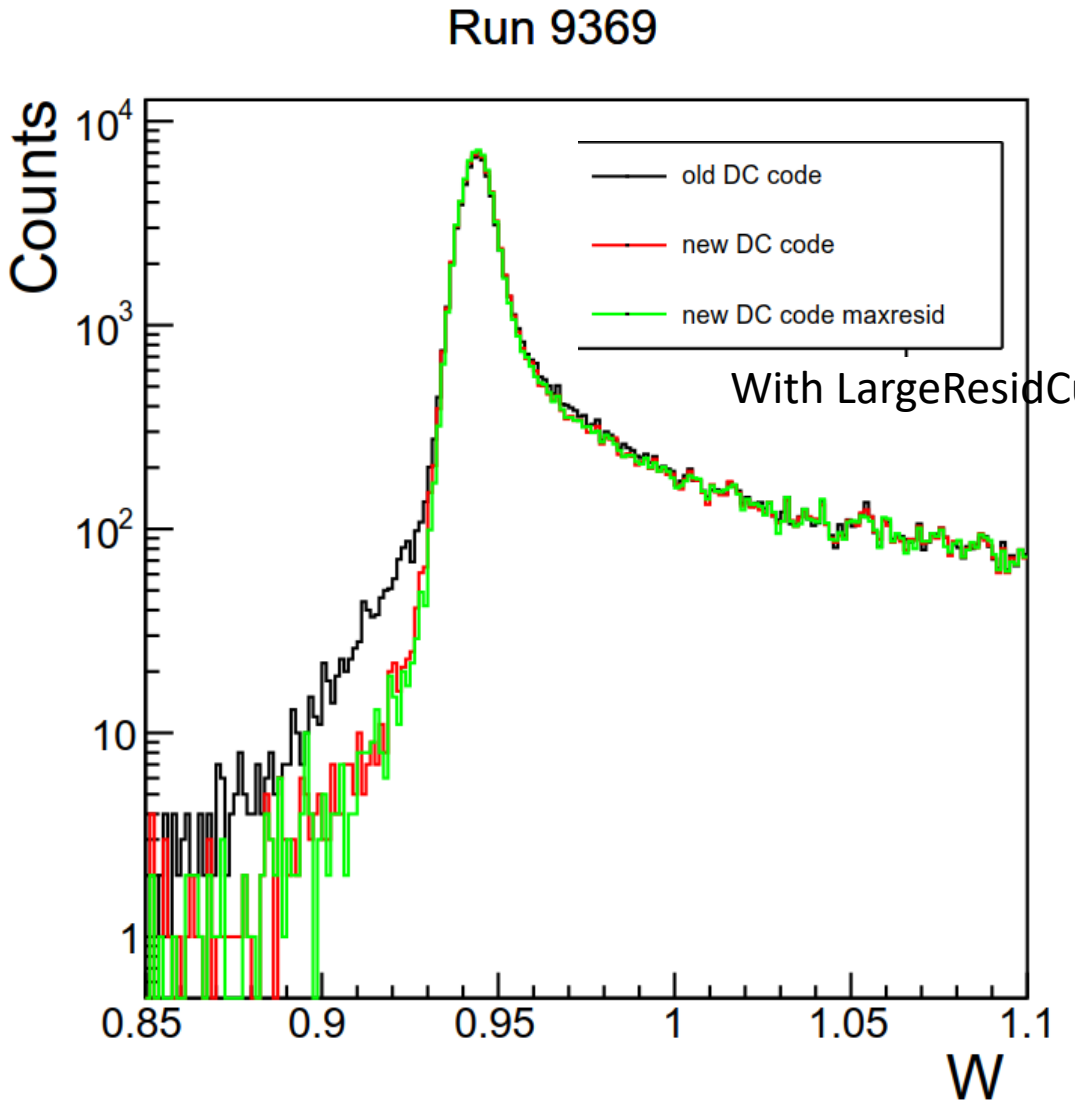
Number of possible tracks

Increased number of possible tracks with new FindSpacePoint even with NewLinkStubs



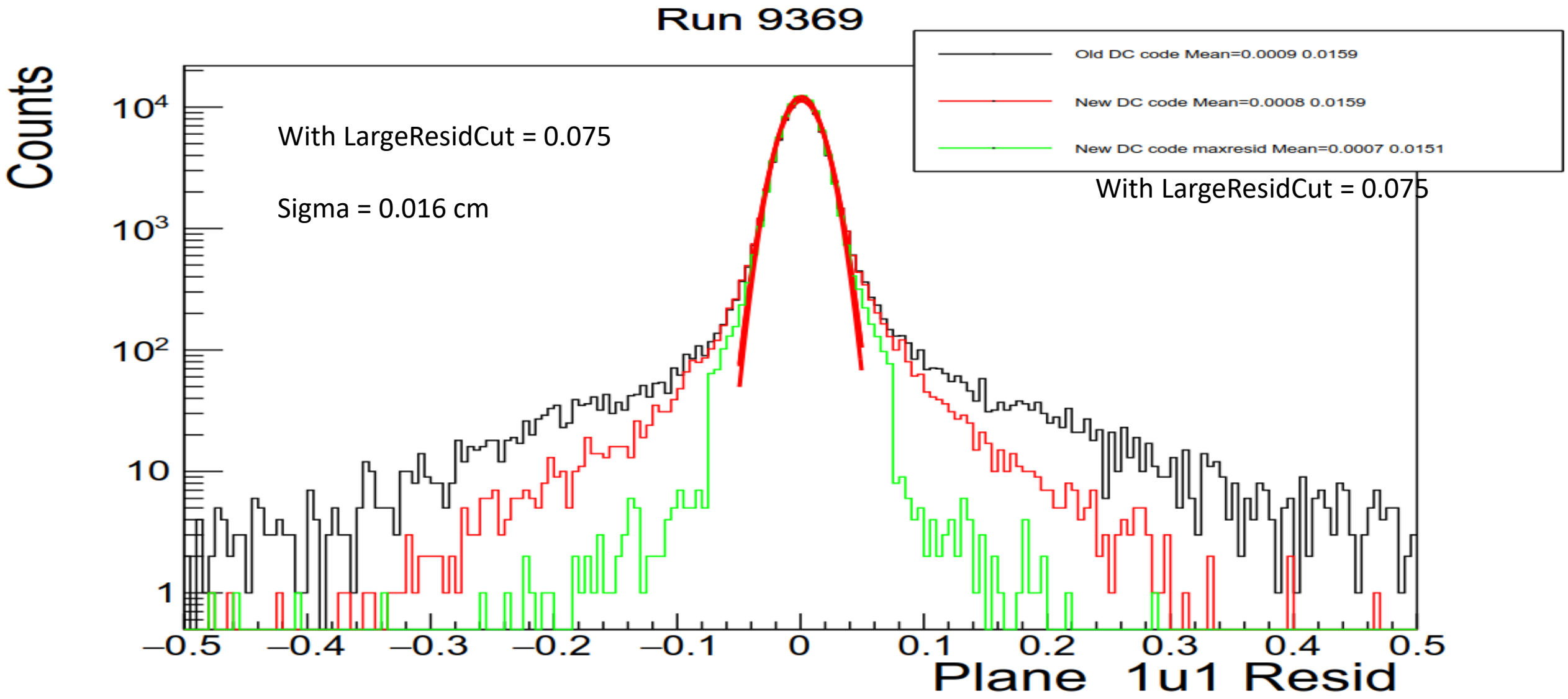
Elastic Coincidence run 9369 during VCS



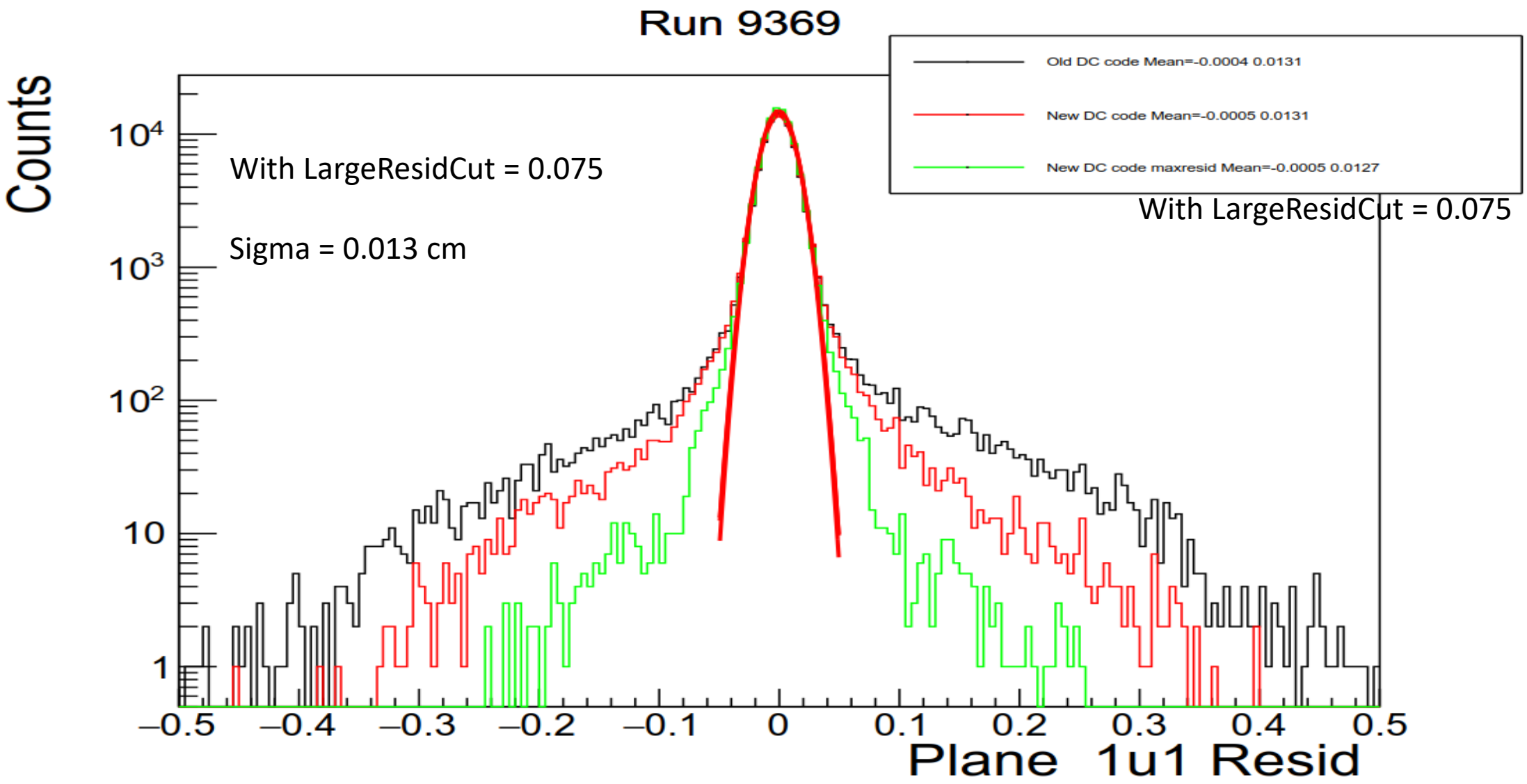


With LargeResidCut = 0.075

SHMS Elastic Coincidence run 9369 during VCS



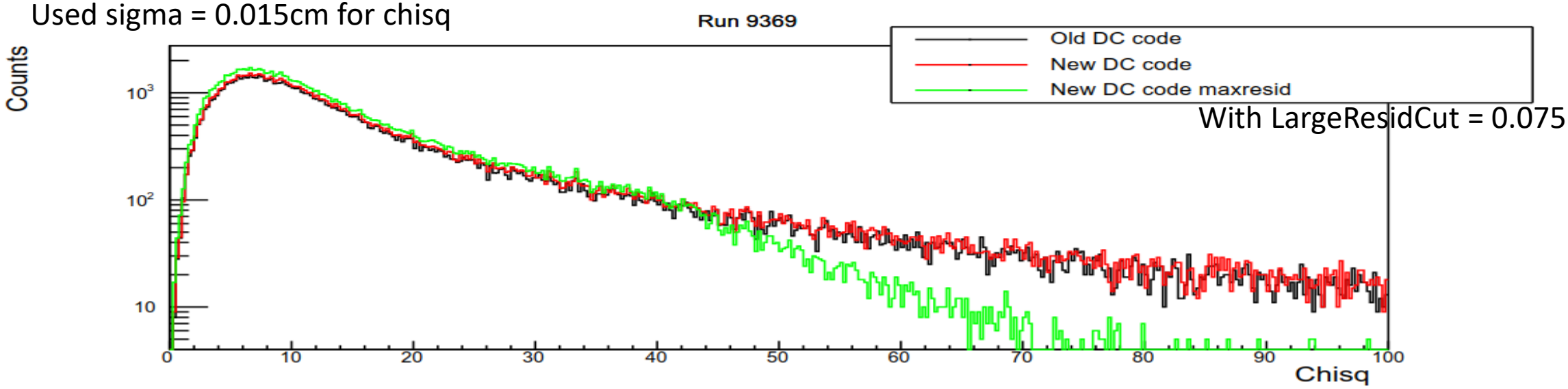
HMS Elastic Coincidence run 9369 during VCS



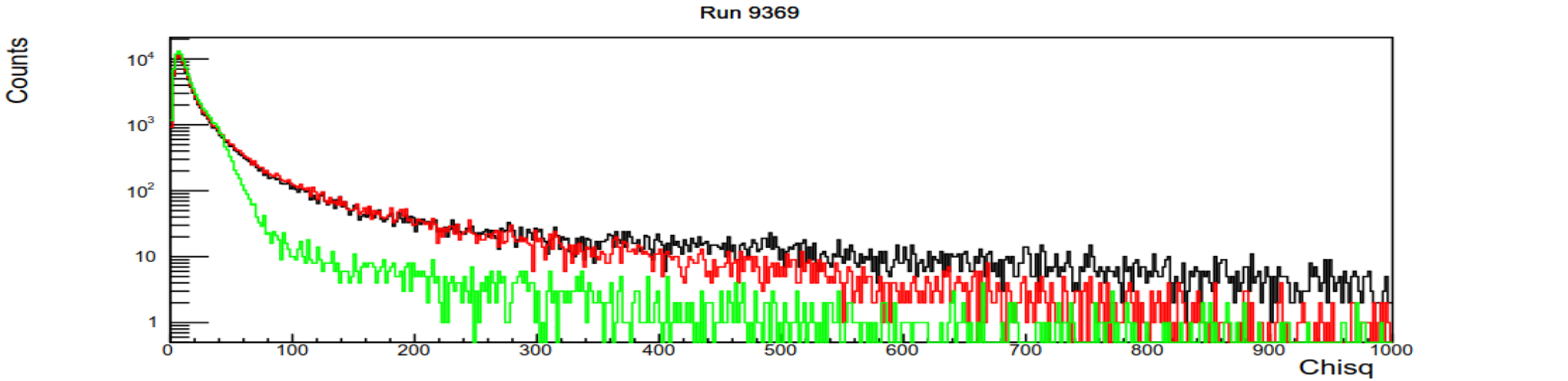
SHMS Elastic Coincidence run 9369 during VCS

Chisq is NOT per DOF, DOF = 8 typically

Used sigma = 0.015cm for chisq

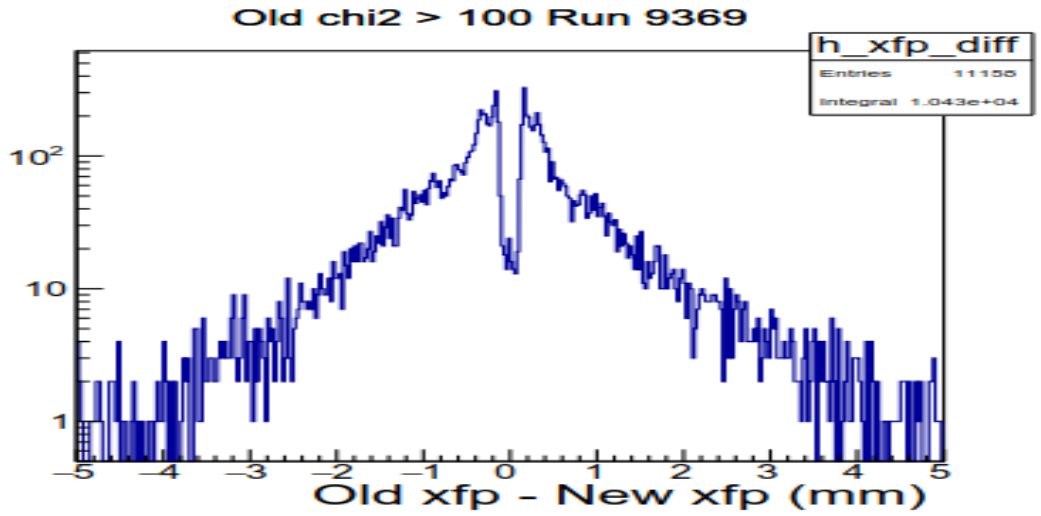


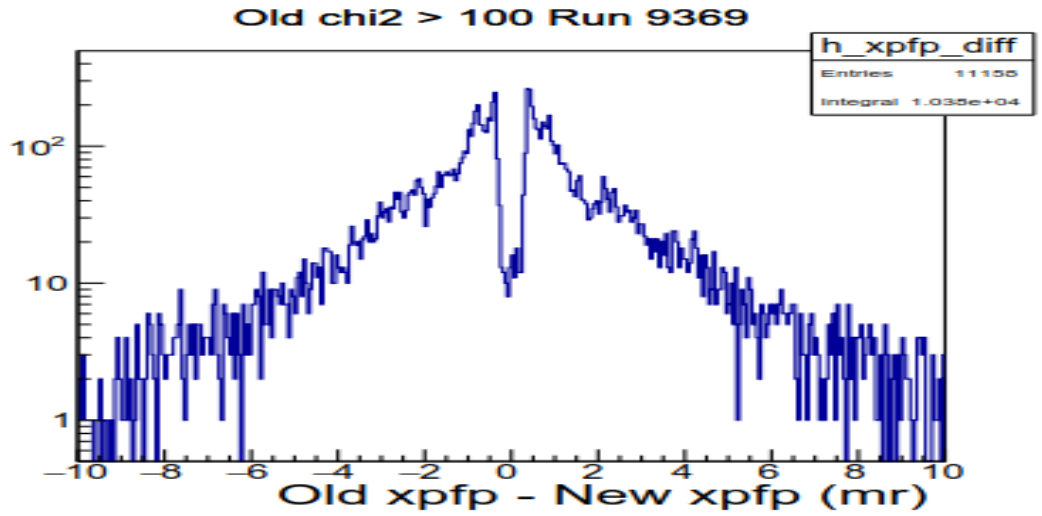
With LargeResidCut = 0.075

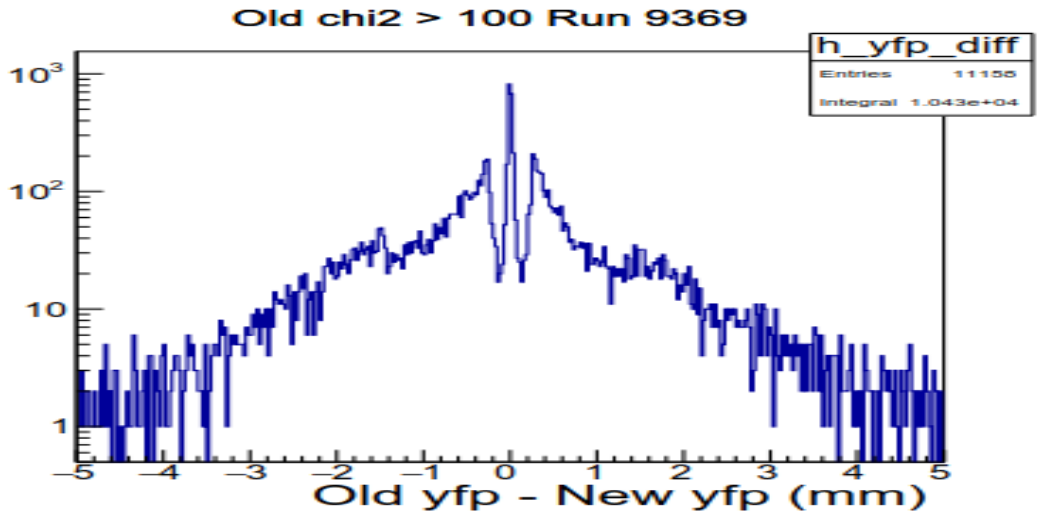


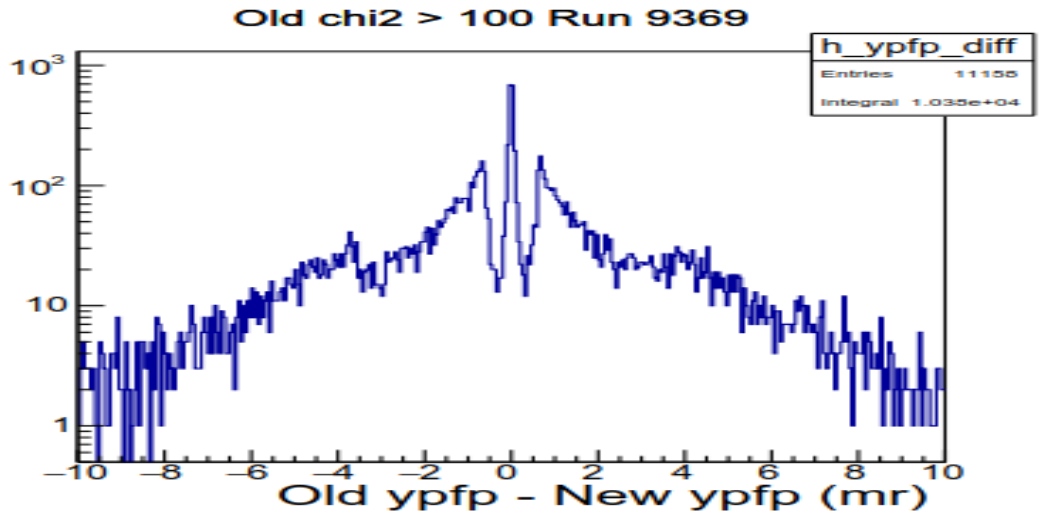
SHMS Elastic Coincidence run 9369 during VCS

Event by event compare old hcana to new hcana at the focal plane





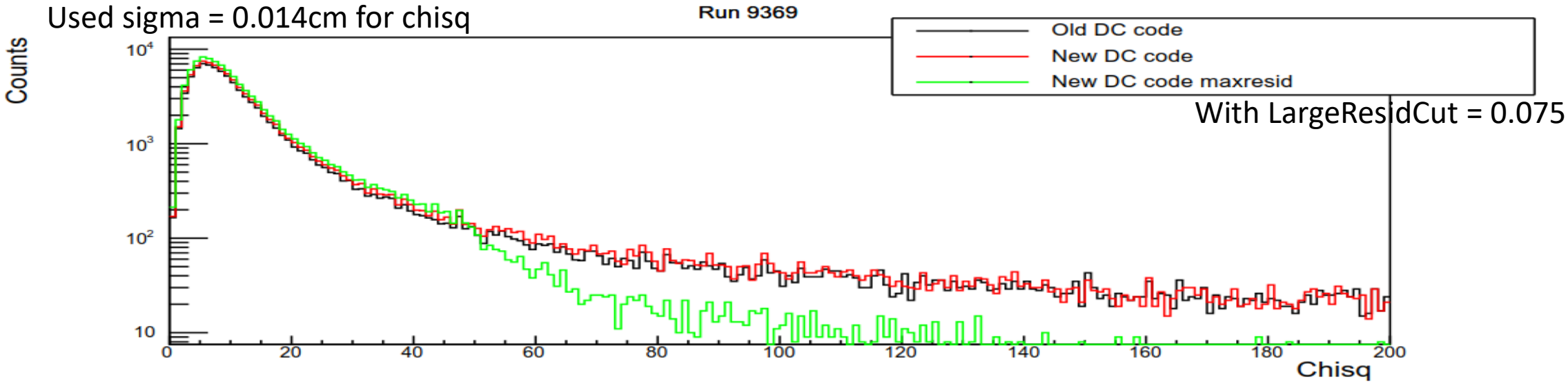




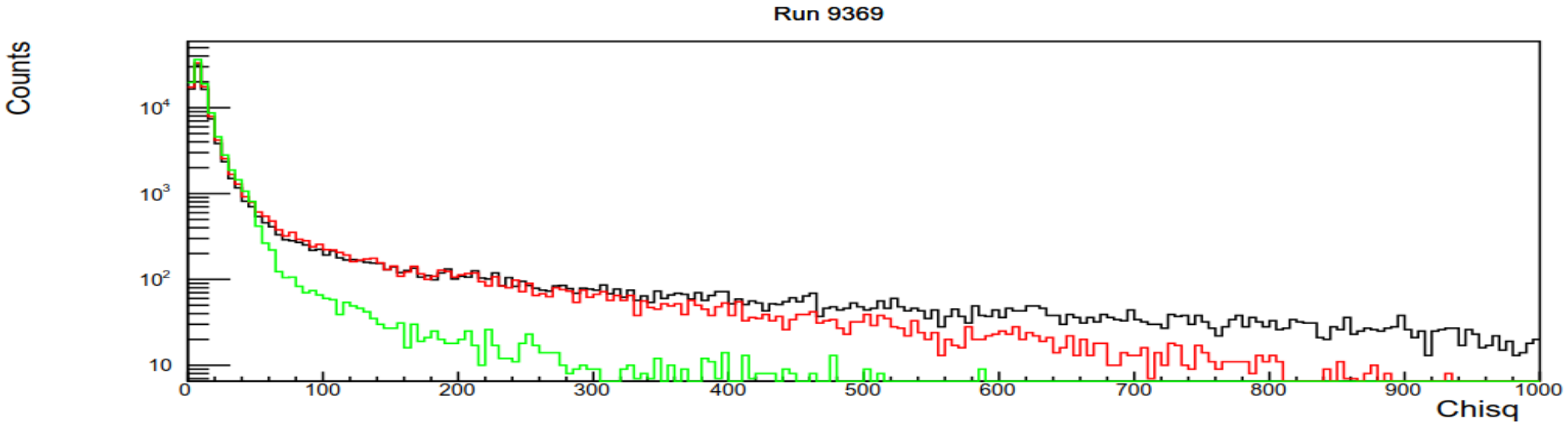
HMS Elastic run 9369 during VCS

Chisq is NOT per DOF, DOF = 8 typically

Used sigma = 0.014cm for chisq

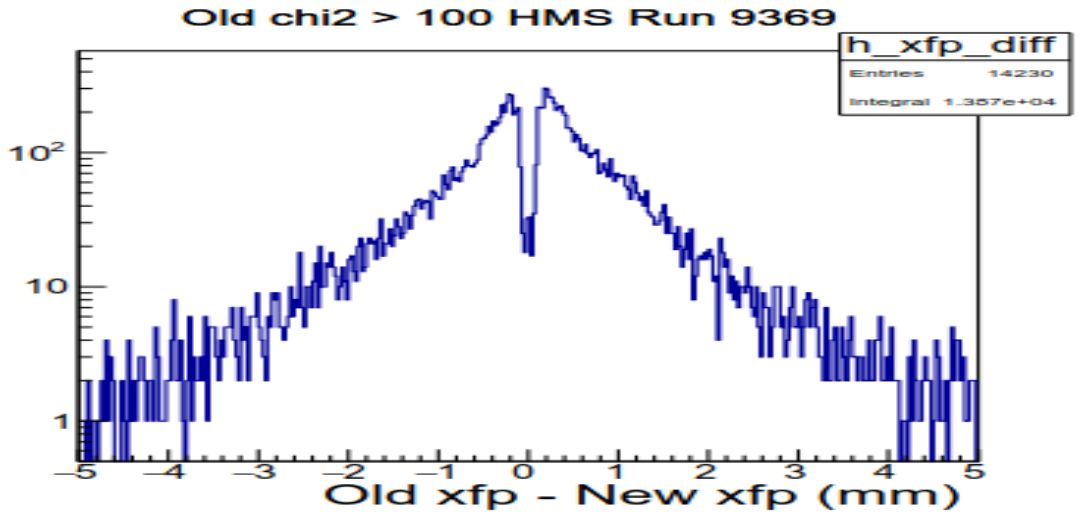


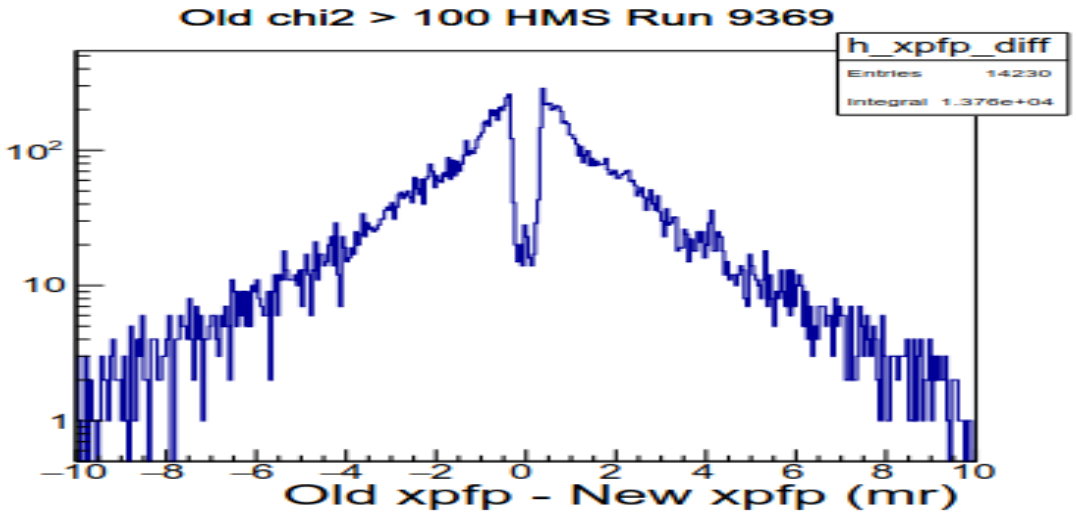
With LargeResidCut = 0.075

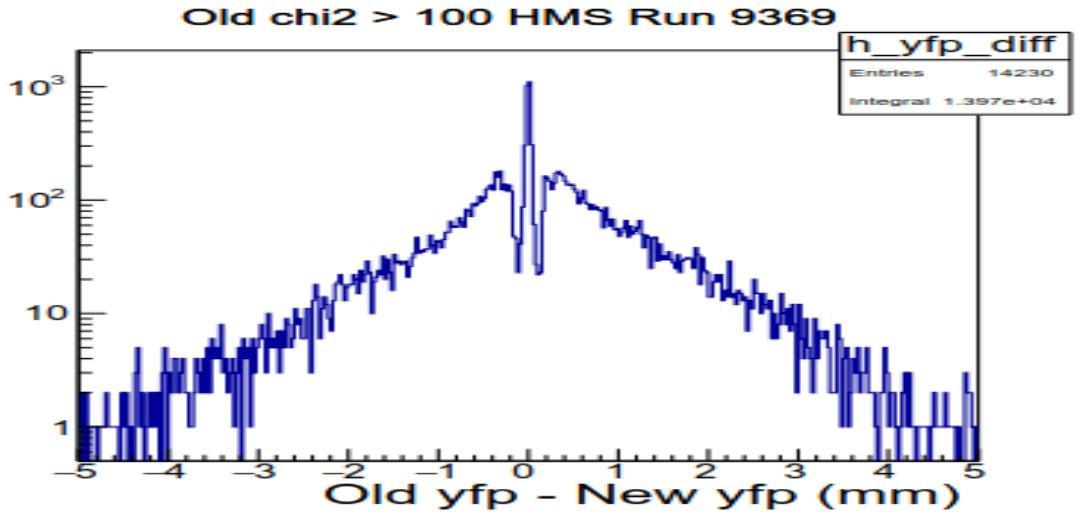


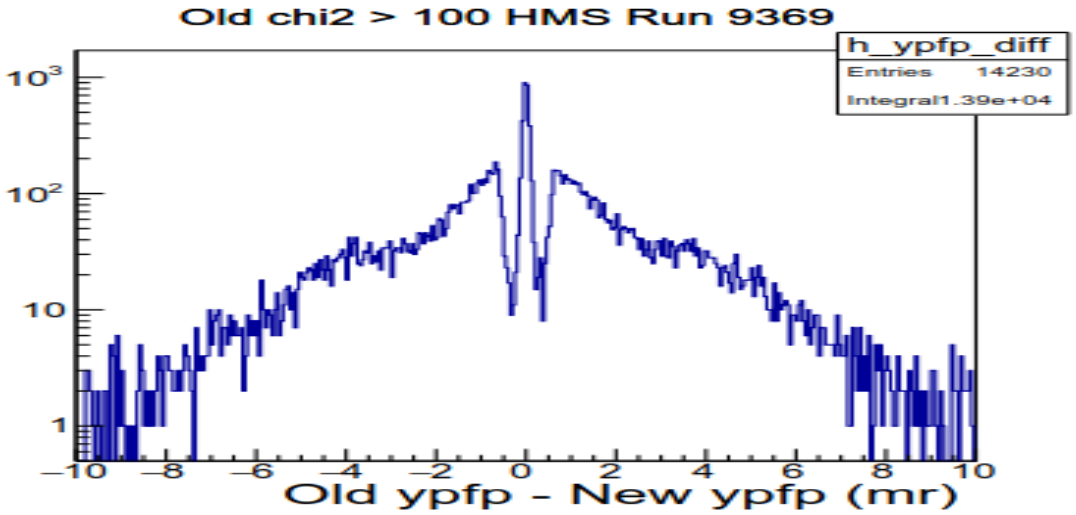
HMS Elastic Coincidence run 9369 during VCS

Event by event compare old hcana to new hcana at the focal plane









Add new tree variables to help with studies

ntracks = 6 Space ID 1 ,2 for best track = 0 0 chi2_best = 10.8277 # of spt = 7
# ch1 sp = 6# ch2 sp = 1
chamber = 1
U hits = 4 -1.38194 -0.881936 -0.381936 0.118064
V hits = 1 -7.67006
X hits = 7 -9.0275 -8.5275 -7.278 -6.278 -5.278 -4.278 -3.278
UX hits = 28 VX hits = 7
UXhit = 0 VXhit = 0 UX ypos = -3.61631 VX ypos = -3.6446 UX xpos = 9.0275 VX xpos = 9.0275 dist2 = 0.000800332
UXhit = 1 VXhit = 1 UX ypos = -3.32763 VX ypos = -3.93327 UX xpos = 8.5275 VX xpos = 8.5275 dist2 = 0.3668
UXhit = 7 VXhit = 0 UX ypos = -4.19366 VX ypos = -3.6446 UX xpos = 9.0275 VX xpos = 9.0275 dist2 = 0.301467
UXhit = 8 VXhit = 1 UX ypos = -3.90498 VX ypos = -3.93327 UX xpos = 8.5275 VX xpos = 8.5275 dist2 = 0.000800332
UXhit = 15 VXhit = 1 UX ypos = -4.48233 VX ypos = -3.93327 UX xpos = 8.5275 VX xpos = 8.5275 dist2 = 0.301467
UXhit = 23 VXhit = 2 UX ypos = -4.33828 VX ypos = -4.65467 UX xpos = 7.278 VX xpos = 7.278 dist2 = 0.100101
chamber = 2
U hits = 1 -2.35763
V hits = 1 -8.13537
X hits = 1 -10.4915
UX hits = 1 VX hits = 1
UXhit = 0 VXhit = 0 UX ypos = -3.33491 VX ypos = -3.33664 UX xpos = 10.4915 VX xpos = 10.4915 dist2 = 2.99991e-0

HCANA DC Update July 2021